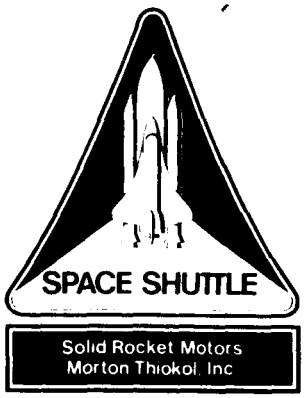

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EVALUATION OF SPINNING RIFFLER FOR AMMONIUM PERCHLORATE SAMPLING

6 April 1989

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EVALUATION OF SPINNING RIFFLER FOR AMMONIUM PERCHLORATE SAMPLING

FINAL REPORT

6 APRIL 1989

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EVALUATION OF SPINNING RIFFLER FOR AMMONIUM PERCHLORATE SAMPLING

W. N. Christensen

1.0 INTRODUCTION

A Gilson Model SP-201 Spinning Riffler has been purchased for evaluation. A test plan (ETP-0487) was written outlining the testing to be accomplished. The test data from the Microtrac study (ETP-0315), which was run on the riffler, provided additional data. Kerr-McGee has been using this type of riffler for some time with excellent reproducible results. This riffler divides the sample into 16 fractions which can then be analyzed.

The old splitter divided the sample in half. This splitter was subject to differences of up to 8 percent without an assignable cause. A new method for sample splitting was needed to ensure reproducible sub-samples for measurement of particle size. The new riffler should meet this requirement.

2.0 OBJECTIVE

The purpose of this study was to evaluate the reproducibility of several sub-samples separated by the spinning riffler by measuring the particle size distribution. The application of the riffler was determined on special coarse, unground (as received) and ground ammonium perchlorate (AP). A procedure for the riffler will be prepared.

3.0 SUMMARY

The data from the riffler were very consistent between sub-samples with differences typically less than 0.3 percent between a series of analyses. The results from the regular splitter has sometimes given differences of several percent. The riffler can be used for splitting ground samples down to 50 micrometers. The ground fraction has given very erratic results in the past due to segregation of the sample. Ground material below 50

micrometers tends to ball up and does not flow freely on the riffler. The riffler is independent of an operator, which is not the case in the present sample splitter. A meeting was held to evaluate the riffler and implement its use for future testing. In attendance at the meeting were representatives from Quality Engineering, R&D Laboratories, Program Management, Material and Process, Configuration Control, Process Engineering, Ballistic/Mass Properties and the Material Specialist. The consensus of the meeting was that the riffler will not change the baseline configuration for AP acceptance, and it should be used for future testing of AP.

4.0 CONCLUSIONS AND/OR RECOMMENDATIONS

The riffler should be used for preparation of unground or special coarse AP samples for particle size analysis. These data are consistent and will eliminate some of the splitting variables seen in the past. The riffler could also be used to split samples of >50 micrometer ground AP if the sample is passed through a coarse sieve prior to riffling. The new riffler will not affect the particle size of the material.

5.0 EQUIPMENT

The new Spinning Riffler, Gilson Model SP-201, and the old splitter, Model SP-326 were used in the study. The samples were tested on a Tyler Rotap using sieves as required for the particle size being determined.

6.0 METHOD

The instruction manual was used for operation of the riffler. SLP-621 was used for splitting the sample and for determination of the particle size of AP.

7.0 DISCUSSION

The program plan (ETP-0487) outlined the tests to be made. The test matrix includes the AP samples used in the Microtrac study and five samples from two unground AP lots. The sample splitter used in the past generally

gives reproducible results, but at times the weight percent retained would vary several percent on the U.S. 70 sieve for no apparent reason. Studies made on the new riffler by both the manufacturer and Kerr-McGee indicate consistent reproducibility between sub-samples from the riffler. In this study, it was found that the riffler gave a consistent sample weight between sub-samples with differences typically less than 0.3 weight percent on the U.S. 70 sieve. The sample from the splitter gave some differences of over 1.0 weight percent on the 70 sieve. See Tables 6 and 8.

The sub-samples for the Microtrac study were all prepared on the riffler, so no splitter samples were available. The 20 micrometer ground AP did not work well on the splitter due to small balls plugging the hopper and changing the flow rate. The other ground samples worked satisfactorily. The test on ground AP could be improved by passing the sample through a coarse (U.S. 20) sieve before riffling.

The selection of the sample size can be varied by using one or more of the 16 sub-samples divided by the riffler. The entire sub-sample should be used rather than any part of it. Normally a one-quart sample will approximately fill all of the tubes. Composites can be made by combining sub-samples from different blends and making another run on the riffler.

The instructions for the riffler did not come with the unit. The first series of tests (Table 3 and Lot 6314-0015) were run using approximately 5 minutes riffling time. After receiving the manufacturer instructions, the time was increased to a minimum of 10 minutes (the manufacturer recommends 15 minutes). An improvement was observed in the reproducibility of the 70 mesh sieve with increased riffling time. This is discussed in the next section. A procedure was written for the operation of the riffler. See Attachment 1.

8.0 DATA AND RESULTS

Tables 1 thru 11 list the data from the particle size analysis by rotap. The Microtrac data will be reported in another report. The same sieve set was used to give comparable analysis. The samples are labeled #1, #2, and

#3, as applicable. Each one is a sub-sample from the same container. The differences are calculated by subtracting the data from sample #2 from sample #1. On the unground AP riffler study, five samples from two lots were tested. From these samples, three sub-samples, (#1, #2, and #3) were prepared using the riffler. From these data all three runs were averaged and the variation of each run from the average was calculated. On lot 7229-0080, one sample was from the top (#4) and the other two were from the bottom of the Econo-Bin.

The test data from the Microtrac study are found in Tables 1 to 5. The samples in this study were all run on the riffler so no splitter data are available for comparison. The sample weight is included to indicate the ability of the riffler to split the sample into equal sub-samples. Table 1 and 2 lists the rotap data from the 75 and 50, and the 100 and 160 micrometer samples of ground material. It has been very difficult to obtain a representative sample of this ground material in the past due to segregation. Differences of 6-12 percent have been observed between duplicate samples. The differences found in this study were over 2 percent in some cases, but were better than normal sampling. The finer fractions would ball up and feed in lumps on the riffler which caused some of the differences observed. If the sample were passed through a coarse screen prior to riffling, the differences would be reduced.

The riffler did not have an instruction manual with it when it arrived. The riffling of the samples started before arrival of the manual. The first samples were only riffled for approximately five minutes. The manual recommends 15 minutes. It can be noted in Table 3 that the differences between the two unground samples were over 0.40 weight percent. The sample 6314-0015 on Table 4 also was run for 5 minutes. The time was increased for the riffling to 10 - 15 minutes. An improvement in the sieve variation was observed as noted on the rest of the unground test data. The differences between sieves from the same sub-sample was less than 0.20 weight percent except for one or two cases. See Tables 6-10.

Samples of 300 and 400 micrometer AP were riffled and particle size was determined. See Table 5. On this material most of the AP is retained on 3 or 4 sieves, making the difference between the two samples small in comparison to the amount retained on the sieve. These data are better than that normally seen on the splitting of coarse AP.

Five samples from two lots were taken to provide a direct comparison between the two methods for preparing sub-samples. Lot 0086 was taken from vendor stream samples and consisted of two samples. Three samples were taken from Lot 7229-0080. These samples were taken from an Econo-Bin. Two of the samples were from the top and one from the bottom. One sample from each lot was also used in the Microtrac study. The sample weight from the splitter sample is not listed because it changes after each sample is split out of the total.

Tables 6-8 list the data from lot 7229-0080. It can be noted that the samples obtained from the splitter (split sample) had greater differences between the two samples than was found between the three riffled samples. Differences greater than 1 percent were observed on the U.S. 70 sieve. The difference between the riffled and splitter sample was larger than the riffler alone. This indicates a possible bias when the splitter is used.

Tables 9-10 list the data from lot 7229-0086. The data from this lot showed better results using the splitter than the riffler. This indicates that at times the splitter is very reproducible. These riffler data are similar to that from the other tests. The difference between the riffler and splitter is similar to lot 0080.

The samples from Lot 0080 were taken from the top and bottom of the same Econo-Bin. This includes one sample used for the Microtrac study. Table 11 lists the average taken from the riffled sample of the top and bottom samples. A bias over 5 weight percent was observed. This information should be used when sampling Econo-Bins to ensure that a representative sample is taken for analysis.

The riffler provides consistent data and is not dependent upon technique of splitting as is the normal splitter. The vendor has also observed a marked improvement in reproducibility of their sub-samples. It is now possible to obtain 16 sub-samples that could be used between MTI and the vendors for AP round robin sieve comparison. This could not be done before because of the variation observed at times in the splitter data.

The splitter will not change any data, but will only improve the reproducibility and consistency of the test results. The riffler should be used for all future tests.

Attachment 1 is an interim procedure for operating the riffler. The important item to observe is the time required to riffle the sample to ensure a complete distribution in each sub-sample.

TABLE 1

75 & 50 MICRON AP
(MICROTRAC STUDY)

		ACM 30013			ACM 30010			988-20017			988-20006		
SIEVE NO.	OPENING MICRONS	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	0.51	0.52	-0.01	0.09	0.09	0.00	0.07	0.08	-0.01	0.05	0.04	0.01
70	212	1.69	1.64	0.05	0.35	0.31	0.04	0.22	0.21	0.01	0.29	0.35	-0.06
80	180	3.59	3.47	0.12	0.93	0.82	0.11	0.37	0.39	-0.02	0.72	0.65	0.07
100	150	7.48	7.45	0.03	2.57	2.48	0.09	0.64	0.68	-0.04	1.18	0.94	0.24
120	125	12.67	12.46	0.21	5.37	5.18	0.19	1.36	1.52	-0.16	2.50	1.92	0.58
140	106	19.73	19.40	0.33	10.66	10.49	0.17	4.52	4.81	-0.29	6.71	5.62	1.09
170	90	28.09	27.67	0.42	18.29	18.28	0.01	13.15	12.90	0.25	16.31	15.18	1.13
200	75	34.02	33.35	0.67	24.90	24.50	0.40	22.31	20.86	1.45	25.43	24.86	0.57
230	63	39.52	38.41	1.11	30.55	30.14	0.41	31.30	28.73	2.57	34.76	33.93	0.83
270	53	44.54	41.75	2.79	35.00	34.45	0.55	38.86	36.08	2.78	50.21	47.26	2.95
325	45	56.91	54.31	2.60	50.35	49.53	0.82	53.98	51.47	2.51	61.96	57.76	4.20
SAMPLE WEIGHT		82.45	82.86	-0.41	82.30	79.90	2.40	79.92	79.36	0.56	82.03	81.03	1.00

		ACM-30011			ACM 30012			988-20146		
SIEVE NO.	OPENING MICRONS	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE1 #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	0.04	0.04	0.00	0.04	0.04	0.00	0.03	0.06	-0.03
70	212	0.12	0.13	-0.01	0.21	0.18	0.03	0.10	0.17	-0.07
80	180	0.36	0.36	0.00	0.61	0.59	0.02	0.25	0.36	-0.11
100	150	1.24	1.30	-0.06	1.87	1.88	-0.01	0.61	0.56	0.05
120	125	3.39	3.38	0.01	4.17	4.21	-0.04	1.70	1.33	0.37
140	106	8.89	8.98	-0.09	9.10	9.19	-0.09	5.62	4.55	1.07
170	90	18.44	18.48	-0.04	16.46	16.49	-0.03	14.76	12.74	2.02
200	75	25.94	25.99	-0.05	22.49	22.46	0.03	23.31	21.54	1.77
230	63	32.54	32.63	-0.09	28.45	28.40	0.05	31.85	29.67	2.18
270	53	37.02	37.15	-0.13	32.84	32.58	0.26	39.86	39.40	0.46
325	45	51.50	51.53	-0.03	47.51	47.30	0.21	55.46	53.08	2.38
SAMPLE WEIGHT		89.95	90.43	-0.48	90.46	90.58	-0.12	81.45	83.88	-2.43

TABLE 2

100 & 160 MICRON AP
(MICROTRAC STUDY)

		988-20144			988-20013		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	2.26	2.42	-0.16	1.63	1.64	-0.01
70	212	5.86	6.75	-0.89	5.41	5.44	-0.03
80	180	12.33	14.72	-2.39	12.27	12.21	0.06
100	150	26.33	28.71	-2.38	24.66	24.58	0.08
120	125	42.68	46.29	-3.61	39.71	39.16	0.55
140	106	56.75	59.78	-3.03	52.78	52.30	0.48
170	90	68.32	70.83	-2.51	64.61	64.22	0.39
200	75	73.85	76.17	-2.32	70.81	70.31	0.50
230	63	78.04	80.17	-2.13	75.80	75.42	0.38
270	53	80.48	86.42	-5.94	83.44	82.41	1.03
325	45	87.11	92.44	-5.33	88.35	86.46	1.89
SAMPLE WEIGHT		109.24	107.67	1.57	121.52	122.09	-0.57

		988-20002			ACM 30014		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	1.84	1.88	-0.04	1.12	1.07	0.05
70	212	5.26	5.21	0.05	3.96	3.89	0.07
80	180	11.01	10.79	0.22	9.09	8.98	0.11
100	150	22.01	22.11	-0.10	19.96	19.88	0.08
120	125	35.72	36.04	-0.32	33.86	33.73	0.13
140	106	49.07	49.49	-0.42	48.94	48.83	0.11
170	90	60.62	61.62	-1.00	63.36	63.15	0.21
200	75	66.55	67.94	-1.39	70.61	70.41	0.20
230	63	71.17	73.45	-2.28	75.96	75.75	0.21
270	53	74.00	81.65	-7.65	79.17	78.95	0.22
325	45	83.27	93.11	-9.84	86.53	86.46	0.07
SAMPLE WEIGHT		104.91	105.85	-0.94	116.61	115.16	1.45

TABLE 2

100 & 160 MICRON AP
(MICROTRAC STUDY)

		988-20144			988-20013		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	2.26	2.42	-0.16	1.63	1.64	-0.01
70	212	5.86	6.75	-0.89	5.41	5.44	-0.03
80	180	12.33	14.72	-2.39	12.27	12.21	0.06
100	150	26.33	28.71	-2.38	24.66	24.58	0.08
120	125	42.68	46.29	-3.61	39.71	39.16	0.55
140	106	56.75	59.78	-3.03	52.78	52.30	0.48
170	90	68.32	70.83	-2.51	64.61	64.22	0.39
200	75	73.85	76.17	-2.32	70.81	70.31	0.50
230	63	78.04	80.17	-2.13	75.80	75.42	0.38
270	53	80.48	86.42	-5.94	83.44	82.41	1.03
325	45	87.11	92.44	-5.33	88.35	86.46	1.89
SAMPLE WEIGHT		109.24	107.67	1.57	121.52	122.09	-0.57

		988-20002			ACM 30014		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
60	250	1.84	1.88	-0.04	1.12	1.07	0.05
70	212	5.26	5.21	0.05	3.96	3.89	0.07
80	180	11.01	10.79	0.22	9.09	8.98	0.11
100	150	22.01	22.11	-0.10	19.96	19.88	0.08
120	125	35.72	36.04	-0.32	33.86	33.73	0.13
140	106	49.07	49.49	-0.42	48.94	48.83	0.11
170	90	60.62	61.62	-1.00	63.36	63.15	0.21
200	75	66.55	67.94	-1.39	70.61	70.41	0.20
230	63	71.17	73.45	-2.28	75.96	75.75	0.21
270	53	74.00	81.65	-7.65	79.17	78.95	0.22
325	45	83.27	93.11	-9.84	86.53	86.46	0.07
SAMPLE WEIGHT		104.91	105.85	-0.94	116.61	115.16	1.45

TABLE 3

UNGROUND AP (1ST TEST)
(MICROTRAC STUDY)

		7229-0086			7229-0080		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
45	355	0.55	0.64	-0.09	0.57	0.53	0.04
50	300	7.19	7.26	-0.07	7.21	7.05	0.16
60	250	22.19	22.32	-0.13	23.38	23.02	0.36
70	212	36.94	37.27	-0.33	38.88	38.53	0.35
80	180	51.87	52.21	-0.34	53.71	53.25	0.46
100	150	70.95	71.22	-0.27	72.26	71.84	0.42
120	125	83.55	83.71	-0.16	84.37	83.97	0.40
140	106	90.91	91.06	-0.15	91.36	91.13	0.23
170	90	95.87	96.12	-0.25	96.14	96.04	0.10
200	75	98.13	98.20	-0.07	98.24	98.20	0.04
230	63	99.51	99.53	-0.02	99.52	99.51	0.01
SAMPLE WEIGHT		109.08	107.59	1.49	126.09	124.94	1.15

TABLE 4

UNGROUND AP (2ND TEST)
(MICROTRAC STUDY)

		6138-0008			6138-0009			7229-0078		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
45	355	0.34	0.35	-0.01	1.04	1.07	-0.03	0.51	0.47	0.04
50	300	0.88	0.86	0.02	2.20	2.32	-0.12	6.03	5.83	0.2
60	250	4.28	4.10	0.18	8.70	8.90	-0.20	19.90	19.87	0.03
70	212	15.20	15.00	0.20	25.67	25.62	0.05	34.75	34.70	0.05
80	180	36.32	35.99	0.33	50.03	49.88	0.15	49.54	49.55	-0.01
100	150	67.74	67.55	0.19	78.63	78.42	0.21	68.69	68.68	0.01
120	125	84.36	84.29	0.07	91.17	91.08	0.09	81.84	81.80	0.04
140	106	90.99	90.95	0.04	95.31	95.32	-0.01	89.40	89.37	0.03
170	90	94.87	94.77	0.10	97.38	97.37	0.01	94.75	94.72	0.03
200	75	96.74	96.66	0.08	98.35	98.33	0.02	97.49	97.50	-0.01
230	63	98.13	98.09	0.04	99.04	99.04	0.00	99.24	99.28	-0.04
SAMPLE WEIGHT		101.55	100.97	0.58	93.02	91.72	1.30	88.54	89.22	-0.68

		6314-0015			6316-0016		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
45	355	4.12	4.09	0.03	1.66	1.66	0.00
50	300	9.82	9.86	-0.04	6.62	6.59	0.03
60	250	17.78	17.67	0.11	14.44	14.44	0.00
70	212	28.54	28.12	0.42	25.93	26.04	-0.11
80	180	45.29	44.69	0.60	44.95	45.05	-0.10
100	150	70.99	70.48	0.51	71.55	71.49	0.06
120	125	86.53	86.32	0.21	85.90	85.89	0.01
140	106	93.28	93.24	0.04	92.00	92.04	-0.04
170	90	96.79	96.99	-0.20	95.54	95.62	-0.08
200	75	98.13	98.16	-0.03	97.10	97.09	0.01
230	63	99.07	99.35	-0.28	98.30	98.34	-0.04
SAMPLE WEIGHT		101.56	102.63	-1.07	107.29	107.26	0.03

TABLE 5

SPECIAL COARSE AP
(MICROTRAC STUDY)

KMCC 5502

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
35	500	0.33	0.29	0.04
40	425	3.18	2.92	0.26
45	355	43.19	42.78	0.41
50	300	81.73	81.73	0.00
60	250	90.58	90.54	0.04
70	212	94.87	94.81	0.06
80	180	96.59	96.52	0.07
100	150	97.59	97.56	0.03
120	125	98.38	98.45	-0.07
SAMPLE WEIGHT		94.98	94.94	

		7812-0021			7812-0030		
SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	DIFF. #1-#2	SAMPLE #1	SAMPLE #2	DIFF. #1-#2
30	600	0.78	0.80	-0.02	0.50	0.46	0.04
35	500	13.52	13.94	-0.42	11.57	11.01	0.56
40	425	52.94	52.72	0.22	46.87	46.06	0.81
45	355	94.78	94.73	0.05	92.13	91.94	0.19
50	300	98.89	98.89	0.00	99.20	99.21	-0.01
60	250	99.24	99.26	-0.02	99.70	99.72	-0.02
70	212	99.43	99.46	-0.03	99.83	99.85	-0.02
80	180	99.54	99.61	-0.07	99.88	99.89	-0.01
100	150	99.61	99.68	-0.07	99.91	99.92	-0.01
120	125	99.67	99.73	-0.06	99.94	99.93	0.01
SAMPLE WEIGHT		116.04	116.81	-0.77	106.83	106.65	0.18

TABLE 6

UNGROUND AP 7229-0080 #3
(RIFFLER STUDY)

RIFFLED SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	SAMPLE #3	AVERAGE ALL	AVERAGE -1	AVERAGE -2	AVERAGE -3	DIFF. HI-LO
45	355	0.83	0.91	0.88	0.87	0.04	-0.04	-0.01	0.08
50	300	8.68	8.61	8.61	8.63	-0.05	0.02	0.02	0.07
60	250	26.69	26.68	26.88	26.75	0.06	0.07	-0.13	0.20
70	212	43.56	43.67	43.84	43.69	0.13	0.02	-0.15	0.28
80	180	58.77	58.92	59.09	58.93	0.16	0.01	-0.16	0.32
100	150	76.77	76.84	77.07	76.89	0.12	0.05	-0.18	0.30
120	125	87.95	87.95	88.10	88.00	0.05	0.05	-0.10	0.06
140	106	93.66	93.69	93.78	93.71	0.05	0.02	-0.07	0.12
170	90	97.30	97.31	97.34	97.32	0.02	0.01	-0.02	0.04
200	75	98.84	98.84	98.87	98.85	0.01	0.01	-0.02	0.03
230	63	99.71	99.72	99.73	99.72	0.01	0.00	-0.01	0.02
SAMPLE WEIGHT		121.49	121.57	123.14	122.07	0.58	0.50	-1.07	1.65

SPLIT SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #4	SAMPLE #5	AVERAGE ALL	AVERAGE -4	AVERAGE -5	DIFF. HI-LO	DIFFERENCE RIFF-SPLIT
45	355	1.02	0.94	0.98	-0.04	0.04	0.08	-0.11
50	300	8.72	8.87	8.80	0.08	-0.08	0.15	-0.17
60	250	26.35	27.11	26.73	0.38	-0.38	0.76	0.02
70	212	42.79	43.94	43.37	0.58	-0.58	1.15	0.33
80	180	58.20	59.09	58.65	0.45	-0.45	0.89	0.29
100	150	76.48	76.99	76.74	0.26	-0.26	0.51	0.16
120	125	87.89	88.07	87.98	0.09	-0.09	0.18	0.02
140	106	93.73	93.75	93.74	0.01	-0.01	0.02	-0.03
170	90	97.41	97.32	97.37	-0.05	0.05	0.09	-0.05
200	75	98.89	98.85	98.87	-0.02	0.02	0.04	-0.02
230	63	99.73	99.72	99.73	0.00	0.01	0.01	-0.01

TABLE 7

UNGROUND AP 7229-0080 #4
(RIFFLER STUDY)

RIFFLED SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	SAMPLE #3	AVERAGE ALL	AVERAGE -1	AVERAGE -2	AVERAGE -3	DIFF. HI-LO
45	355	0.71	0.75	0.68	0.71	0.00	-0.04	0.03	0.07
50	300	7.41	7.44	7.40	7.42	0.01	-0.02	0.02	0.04
60	250	23.39	23.22	23.15	23.25	-0.14	0.03	0.10	0.24
70	212	39.15	38.97	38.88	39.00	-0.15	0.03	0.12	0.27
80	180	53.94	53.79	53.69	53.81	-0.13	0.02	0.12	0.25
100	150	72.38	72.25	72.12	72.25	-0.13	0.00	0.13	0.26
120	125	84.45	84.39	84.31	84.38	-0.07	-0.01	0.07	0.14
140	106	91.22	91.18	91.12	91.17	-0.05	-0.01	0.05	0.10
170	90	95.80	95.87	95.85	95.84	0.04	-0.03	-0.01	0.07
200	75	98.11	98.12	98.12	98.12	0.01	0.00	0.00	0.01
230	63	99.50	99.51	99.51	99.51	0.01	0.00	0.00	0.01
SAMPLE WEIGHT		136.11	133.16	132.65	133.97	-2.14	0.81	1.32	3.46

SPLIT SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #4	SAMPLE #5	AVERAGE ALL	AVERAGE -4	AVERAGE -5	DIFF. HI-LO	DIFFERENCE RIFF-SPLIT
45	355	0.66	0.76	0.71	0.05	-0.05	-0.10	0.00
50	300	7.24	7.54	7.39	0.15	-0.15	-0.30	0.03
60	250	22.79	23.36	23.08	0.29	-0.29	-0.57	0.18
70	212	37.90	38.60	38.25	0.35	-0.35	-0.70	0.75
80	180	52.73	53.42	53.08	0.35	-0.35	-0.69	0.73
100	150	71.43	71.97	71.70	0.27	-0.27	-0.54	0.55
120	125	83.99	84.36	84.18	0.19	-0.19	-0.37	0.21
140	106	91.02	91.33	91.18	0.16	-0.16	-0.31	0.00
170	90	95.88	96.10	95.99	0.11	-0.11	-0.22	-0.15
200	75	98.13	98.22	98.18	0.05	-0.05	-0.09	-0.06
230	63	99.51	99.54	99.53	0.02	-0.01	-0.03	-0.02

TABLE 8

UNGROUND AP 7229-0080 #7
(RIFFLER STUDY)

RIFFLED SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	SAMPLE #3	AVERAGE ALL	AVERAGE -1	AVERAGE -2	AVERAGE -3	DIFF. HI-LO
45	355	0.81	0.79	0.81	0.80	-0.01	0.01	-0.01	0.02
50	300	8.56	8.39	8.48	8.48	-0.08	0.09	0.00	0.08
60	250	26.29	26.28	26.30	26.29	0.00	0.01	-0.01	0.02
70	212	43.32	43.22	43.28	43.27	-0.05	0.05	-0.01	0.10
80	180	58.60	58.58	58.69	58.62	0.02	0.04	-0.07	0.11
100	150	76.70	76.68	76.74	76.71	0.01	0.03	-0.03	0.06
120	125	87.81	87.79	87.84	87.81	0.00	0.02	-0.03	0.05
140	106	93.52	93.51	93.59	93.54	0.02	0.03	-0.05	0.08
170	90	97.23	97.22	97.28	97.24	0.01	0.02	-0.04	0.06
200	75	98.77	98.78	98.80	98.78	0.01	0.00	-0.02	0.02
230	63	99.69	99.68	99.72	99.70	0.01	0.02	-0.02	0.04
SAMPLE WEIGHT		124.78	124.39	125.45	124.87	0.09	0.48	-0.58	-0.67

SPLIT SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #4	SAMPLE #5	AVERAGE ALL	AVERAGE -4	AVERAGE -5	DIFF. HI-LO	DIFFERENCE RIFF-SPLIT
45	355	0.79	0.85	0.82	0.03	-0.03	0.06	-0.02
50	300	8.29	8.40	8.35	0.06	-0.06	0.11	0.13
60	250	25.73	26.24	25.99	0.26	-0.26	0.51	0.31
70	212	42.04	43.30	42.67	0.63	-0.63	1.26	0.60
80	180	57.55	58.50	58.03	0.48	-0.48	0.95	0.60
100	150	75.95	76.56	76.26	0.31	-0.31	0.61	0.45
120	125	87.42	87.65	87.54	0.12	-0.12	0.23	0.28
140	106	93.42	93.39	93.41	-0.01	0.02	-0.03	0.14
170	90	97.28	97.10	97.19	-0.09	0.09	-0.18	0.05
200	75	98.78	98.71	98.75	-0.03	0.04	-0.07	0.04
230	63	99.68	99.66	99.67	-0.01	0.01	-0.02	0.03

TABLE 9

UNGROUND AP 7229-0086 #196
(RIFFLER STUDY)

RIFFLED SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	SAMPLE #3	AVERAGE ALL	AVERAGE -1	AVERAGE -2	AVERAGE -3	DIFF. HI-LO
45	355	0.86	0.92	0.89	0.89	0.03	-0.03	0.00	0.06
50	300	7.93	7.93	7.94	7.93	0.00	0.00	-0.01	0.01
60	250	23.82	23.87	23.99	23.89	0.07	0.02	-0.10	0.17
70	212	39.79	39.93	39.91	39.88	0.09	-0.05	-0.03	0.14
80	180	54.83	54.96	55.04	54.94	0.11	-0.02	-0.10	0.21
100	150	73.39	73.46	73.47	73.44	0.05	-0.02	-0.03	0.08
120	125	85.30	85.33	85.36	85.33	0.03	0.00	-0.03	0.06
140	106	91.74	91.77	91.81	91.77	0.03	0.00	-0.04	0.07
170	90	96.12	96.15	96.19	96.15	0.03	0.00	-0.04	0.07
200	75	98.19	98.21	98.23	98.21	0.02	0.00	-0.02	0.04
230	63	99.48	99.51	99.52	99.50	0.02	-0.01	-0.02	0.04
SAMPLE WEIGHT		124.62	124.86	124.09	124.52	-0.10	-0.34	0.43	0.77

SPLIT SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #4	SAMPLE #5	AVERAGE ALL	AVERAGE -4	AVERAGE -5	DIFF. HI-LO	DIFFERENCE RIFF-SPLIT
45	355	0.86	0.85	0.86	-0.01	0.01	-0.01	0.04
50	300	7.73	7.76	7.75	0.02	-0.02	0.03	0.19
60	250	23.49	23.40	23.45	-0.05	0.05	-0.09	0.45
70	212	39.30	39.23	39.27	-0.04	0.04	-0.07	0.61
80	180	54.39	54.46	54.43	0.04	-0.04	0.07	0.52
100	150	73.00	72.94	72.97	-0.03	0.03	-0.06	0.47
120	125	85.05	85.01	85.03	-0.02	0.02	-0.04	0.30
140	106	91.64	91.60	91.62	-0.02	0.02	-0.04	0.15
170	90	96.10	96.05	96.08	-0.02	0.03	-0.05	0.08
200	75	98.18	98.16	98.17	-0.01	0.01	-0.02	0.04
230	63	99.49	99.48	99.49	0.00	0.01	-0.01	0.02

TABLE 10

UNGROUND AP 7229-0086 #250
(RIFFLER STUDY)

RIFFLED SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #1	SAMPLE #2	SAMPLE #3	AVERAGE ALL	AVERAGE -1	AVERAGE -2	AVERAGE -3	DIFF. HI-LO
45	355	0.70	0.72	0.78	0.73	0.03	0.01	-0.05	0.08
50	300	6.73	6.70	6.68	6.70	-0.03	0.00	0.02	0.05
60	250	20.51	20.53	20.66	20.57	0.06	0.04	-0.09	0.15
70	212	35.15	35.13	35.40	35.23	0.08	0.10	-0.17	0.25
80	180	49.70	49.68	50.00	49.79	0.09	0.11	-0.21	0.30
100	150	68.70	68.76	69.03	68.83	0.13	0.07	-0.20	0.33
120	125	81.93	81.99	82.07	82.00	0.07	0.01	-0.07	0.14
140	106	89.58	89.36	89.65	89.53	-0.05	0.17	-0.12	0.17
170	90	94.96	95.02	95.02	95.00	0.04	-0.02	-0.02	0.06
200	75	97.73	97.75	97.75	97.74	0.01	-0.01	-0.01	0.02
230	63	99.41	99.42	99.42	99.42	0.01	0.00	0.00	0.01
SAMPLE WEIGHT		127.23	127.28	129.11	127.87	0.64	0.59	-1.24	-1.88

SPLIT SAMPLE

SIEVE NO.	OPENING MICRON	SAMPLE #4	SAMPLE #5	AVERAGE ALL	AVERAGE -4	AVERAGE -5	DIFF. HI-LO	DIFFERENCE RIFF-SPLIT
45	355	0.70	0.81	0.76	0.06	-0.06	0.11	-0.02
50	300	6.89	6.93	6.91	0.02	-0.02	0.04	-0.21
60	250	20.83	21.02	20.93	0.10	-0.10	0.19	-0.36
70	212	35.49	35.55	35.52	0.03	-0.03	0.06	-0.29
80	180	50.01	50.12	50.07	0.06	-0.06	0.11	-0.27
100	150	68.92	69.05	68.99	0.07	-0.07	0.13	-0.16
120	125	81.93	82.09	82.01	0.08	-0.08	0.16	-0.01
140	106	89.56	89.70	89.63	0.07	-0.07	0.14	-0.10
170	90	94.97	95.10	95.04	0.07	-0.07	0.13	-0.04
200	75	97.72	97.78	97.75	0.03	-0.03	0.06	-0.01
230	63	99.39	99.42	99.41	0.02	-0.01	0.03	0.01

TABLE 11

RIFFLER STUDY
COMPARISISON OF LOT 7229-0080

SIEVE #	OPENING	SAMPLE #4 TOP AVERAGE	SAMPLE #2 TOP AVERAGE	SAMPLE #7 BOTTOM AVERAGE	SAMPLE # 3 BOTTOM AVERAGE
45	355	0.71	0.55	0.80	0.87
50	300	7.41	7.21	8.48	8.63
60	250	23.39	23.20	26.29	26.75
70	212	39.15	38.61	43.27	43.69
80	180	53.94	53.49	58.62	58.93
100	150	72.38	72.06	76.71	76.89
120	125	84.45	84.17	87.81	88.00
140	106	91.22	91.25	93.54	93.71
170	90	95.80	96.09	97.24	97.32
200	75	98.11	98.22	98.78	98.85
230	63	99.50	99.51	99.70	99.72

AVERAGE BOTTOM	DIFF. BOTTOM	AVERAGE TOP	DIFF. TOP	BOTTOM - TOP
0.84	0.07	0.63	0.16	0.21
8.56	0.15	7.31	0.20	1.25
26.52	0.46	23.30	0.19	3.23
43.48	0.42	38.88	0.54	4.60
58.78	0.31	53.72	0.45	5.06
76.80	0.18	72.22	0.32	4.58
87.91	0.19	84.31	0.28	3.60
93.63	0.17	91.24	-0.03	2.39
97.28	0.08	95.95	-0.29	1.34
98.82	0.07	98.17	-0.11	0.65
99.71	0.02	99.51	-0.01	0.21

ATTACHMENT 1

Procedure for Operating The SP-201 Spinning Riffler

1. Insure all the tubes are clean and dry. Clean 16 hole table if required. Do not heat the table above 100 degrees C in drying.

2. Insert tubes in the holes as required. Place the table on the riffler driving spindle. Mount the dividing top on the table by aligning the two drive lugs in the holes.

3. Adjust, as necessary, the nuts on the hopper to provide clearance on the vibrator tray.

4. Plug in the power cord. Slowly pour the sample into the hopper to avoid dusting. The maximum sample size is 1 quart. For ground material, pass the sample through 20 mesh sieve to break up the lumps before riffling.

5. Set vibrator setting to 7 for unground material or 8.5 to 9 for ground material.

6. Turn the power switch on and note feed rate. Adjust vibrator setting to provide at least a 10 minute operating time to the riffle the sample.

7. Insure that the sample does not overflow the test tubes.

8. Remove the dividing top and lift the table of the spindle. Remove the tubes from the table. Combine two or more tubes if required to provide enough sample for particle size analysis. Composite samples can be made by combining tubes from different runs in to one sample. Then riffle that sample.

9. Clean riffler, vibrator, test tubes and table as required. See riffler operating instructions for maintenance and cleaning.

DISTRIBUTION

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